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ABSTRACT

This study sought to examine to what extent language learners in an immersion classroom used their native language and the foreign language when performing the cognitive operations involved in math word problems. Thirty-two third- through sixth-graders in a Spanish immersion program participated in the study. Data were collected through: (1) interviews; (2) student questionnaires that covered pupils' abilities, attitudes, and preferences with regard to thinking in Spanish; (3) classroom observations; and (4) background information such as school grades, achievement test scores, and extracurricular exposure to Spanish. The findings revealed that English seemed at times to play a more prominent role in the students' internal language environment than did Spanish. In responding to word problems in math, fifth- and sixth-graders reported favoring English in their cognitive processing and were also observed to be doing so. They would read the problem in Spanish but would shift to English immediately or as soon as they had some conceptual difficulty. (Contains 18 references.) (MDM)

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The Processing of Foreign-Language Reading Tasks in Immersion Classrooms

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Summary

This paper will explore what it means to read in the foreign language in a full immersion program. In order to address the issue of reading, we will begin by considering what it means to think in a foreign language. We will then look at the role of mental translation in reading. Finally, we will consider the findings from a study on the use of Spanish and English language for performing cognitive operations in classrooms in a full immersion school in St. Paul.

The Language of Thought in Learning and Using a Foreign Language

The successful results from the research on full immersion programs have led to claims that immersion pupils gain an ability "to think in the foreign language." The assumption being made is that the more adept learners are at thinking in that language, the quicker they will be able to process input and output and consequently enhance their acquisition of that language all the more. There appear to be strong beliefs on the part of many language educators, teaching methodologists, and teachers that learners should make every effort to think in the FL while they are learning and using it.

Yet along with the documented success of immersion programs in producing bilinguals who can function in a foreign language, there is a realization that there are gaps in foreign-language proficiency, especially in speaking and writing skills. There are signs that pupils sometimes use English-language structures to construct their utterances but substitute foreign-language words, a process referred to as *relexification*. Pupils also insert native-language words into their utterances, especially adverbs and interjections–a sign that they may be thinking in English and performing on-line translation. Finally, the language produced in immersion programs is seen to have reduced vocabulary and structure (e.g., little or no use of certain complex verb tenses such as the conditional or the subjunctive), similar to various pidgin languages.

French immersion research, for example, has shown that in spite of having had a number of years of comprehensible input in French, the students' spoken and written French contains numerous morphological, syntactic, and lexical deviations from native-speaker norms (Lapkin, Swain, & Shapson 1990, Genesee 1987). In addition, observations of immersion classrooms apparently indicate that students have relatively little opportunity for the use of extended discourse in class. One study of more than ten 6th-grade French immersion classes found that only 14% of the times that students spoke in teacher-fronted activities were their utterances longer than a clause in length (Swain 1988, Harley, Allen, Cummins, & Swain 1988.)

The enormous strides taken in full immersion programs to totally immerse young learners in the foreign language are consistent with the goal of stimulating foreign-language (FL) thought. The intention is to have learners avoid translating or *reprocessing* the material into their first language (the L1). The extent and nature of FL thinking can vary from minimal, passing thoughts (e.g., just a word or two) to more extensive and "deeper" (i.e., more cognitively complex) ones, depending both on the

nature and quality of the language acquisition process (e.g., more of an L2 context where the language is in the environment as opposed to an FL context where the language is not in the environment), and on the degree to which the learner has mastery over the FL.

Unless the learners are thinking out loud when they read, their thoughts reflect *inner speech*–the thinking they do in their minds that is in the form of words rather than images or symbols. This inner speech could be both *private* in the Vygotskian sense (i.e., not intended for others and perhaps difficult to interpret because it is incomplete in grammatical form and vocabulary but adequate for the thinker) or *public* (i.e., interpretable by others) (Vygotsky 1961). In order for inner speech to take place in the FL, the learners may need to attain a certain functional level with regard to vocabulary and structure. Some areas of thought may be more demanding than others for given learners. An empirical question is one of threshold: how well do learners need to function in a language in order to think in that language? If we accept that premise that a thought with even just a word or two of the new language in it comprises a bilingual thought, then we could say that thinking can take place in an FL early on in the language learning process.

We should note that when nonnative readers think in the FL while they read, their verbalized thoughts will most likely reflect those of a nonnative using the FL. In other words, while the thoughts that FL readers have in the FL will at times reflect exactly the way natives would think them, at other times their thoughts will reflect translation of English-language thoughts. Hence, some of the thoughts may be qualitatively different by virtue of the sociocultural assumptions behind them since the content and associative networks of the thoughts will be influenced by the reader's native culture. Obviously within the same culture there may be systematic differences in thinking due to experience, gender, and so forth. Since there does not appear to be research in this area, we can only speculate as to the extent to which nonnative thoughts of young immersion pupils are in the FL and the influence that this has on the reading process.

It is also likely that thinking in an FL may be more likely in a *discourse domain* over which the learner has greater control. It has been hypothesized in the literature that learners create their own highly personal discourse domains (Selinker & Douglas 1985), and research has suggested that nonnatives with limited language proficiency can still be more conversant in talking about content within their discourse domain than less knowledgeable native speakers (Zuengler 1993).

Another way to characterize thoughts might be through distinguishing those of an academic nature from those of an interpersonal or social nature, consistent with the distinction between academic and conversational language proficiency currently being made by Cummins (1991). If learners wanted to use the FL to think through a word problem in math or refine the research questions for a research study, then they would need to call on their academic language proficiency in the FL in order to do so. Likewise, if they wanted to think FL thoughts of a social nature, possibly even emotionally charged (e.g., planning a complex speech act, such as complaining, apologizing, or making a delicate request; relating an emotional upset to a close friend),

then the learners would need the appropriate conversational language proficiency in the FL.

In certain language contexts, immersion pupils may only be able to think about the material in the foreign language. They may not know how to think about certain school-related issues in their L1 if their only exposure to the material is in the FL, and if, in addition, they have done little or no reprocessing of this FL material into their L1. In other domains, such as that of social interaction, the language of thought in social interaction may be the L1, especially when there is little or no peer contact at school with native speakers of that foreign language.

The Role of Mental Translation in Reading

While the field of language learning has begun to investigate the strategies that learners use to succeed at FL learning (O'Malley & Chamot 1990, Cohen 1990), the issue of the language of thought in learning and using a foreign language has not received much attention in the research literature. The focus has been more on product than on process. For example, Malakoff (1992) had fourth and fifth-grade bilinguals perform oral translation tasks involving ambiguity and word/sentence segmentation where the native- and foreign-language patterns were at odds. What has not been explored with young bilinguals is their mental translation.

Kern (in press) has recently conducted empirical research which provides new insights into the actual uses for mental translation in foreign-language reading. Although his research dealt with college-level readers of French, it would seem to have implications for elementary-school immersion classrooms as well.

Kern had 51 intermediate-level students of college French (in high, medium, and low reading ability groups) participate in verbal report interviews while reading French texts at the beginning and the end of a fifteen-week semester. An analysis of the verbal report data provided a series of reasons for why the learners of French chose to perform mental translation into their L1, English. The study provided a number of insights as to why FL learners may well choose to think through their L1 instead:

1. By so doing, the learners have an easier time processing the thought since L1 processing facilitates semantic processing. For example, learners may have a more difficult time chunking FL lexical items into semantic clusters than they do with translated items. If the learners stay only in the FL, they are more likely to store words as discrete units in working memory, which in turn places a greater burden on memory capacity.

2. If learners process the input exclusively in the FL, they run the risk of losing lose their train of thought as soon as the chunks are long or syntactically complex, since they are harder to hold in short-term memory. Indulging in mental translation during FL aural comprehension or reading, on the other hand, is likely to allow the learner to represent in a familiar, memory-efficient form, portions of

the oral or written FL text that exceed cognitive limits. Translation then serves as a means of maintaining concentration long enough for meaning to be integrated and assimilated.

3. By thinking in the L1, the concepts are likely to come alive because the learners' network of associations is usually richer than in the foreign language. The semantic potency of words may simply be less in the FL than in the L1.

4. Thinking in the L1 converts the input into more familiar, user-friendly terms, enhancing the learners' confidence about their ability to comprehend it. This may serve as an affective boost, reducing the insecurity they may feel.

5. Learners may also revert to the L1 because they have found that it helps them in clarifying syntactic roles, verifying a verb tense, or checking for comprehension (Kern, in press).

The fact that learners resort somewhat or extensively to the use of the L1 does not necessarily mean that translation works to the learner's advantage. For example:

1. Attempts at translation may be inaccurate, leading to miscomprehension.

2. Translations done too much on a word-by-word basis at the micro-level may not adequately provide for integration of meaning. Hence, the learner may come away with a bottom-up sense of how portions of text and isolated items function and what they mean, without having an overall, top-down sense of what the material is all about.

3. Learners who are translating during language processing may be attending to FL forms only very briefly and reserving the bulk of meaning processing for the L1 mental representation. In other words, it is possible that during much of the meaning-integration process, learners focus primarily on transformed L1 representations rather than on the original FL forms. If this is the case, the FL input may have little impact on the learners' acquisition of the FL forms, and hence, not much FL acquisition would be expected to take place.

Having given the potential hazards of translation, let us also consider some of the benefits:

1. Translation (of individual words) has been seen to call for deeper language processing than simply copying down the word as is in the foreign language, and this act of translation has helped to fix the word more solidly in memory (Paivio & Lambert 1981).

2. Translation can at times provide a level of clarity lacking in "direct" methods

which insist on no use of the L1 even though serious misunderstandings may sometimes result.

3. There may be advantages of a cognitive nature that come from skillful two-language translation-bouncing (Wallace Lambert, Personal Communication, January 14, 1994). Skillful translation would mean doing it so swiftly and successfully that no one could call it a crutch and few would even be aware that it is going on.

The Language of Thought for Reading in Full Immersion Classrooms

An empirical study was designed to examine the nature of the internal language environment that emerges in learners as a result of the specific *external language environment* established in immersion classrooms. Using the learner as the locus of reference, the external language environment was defined as all language-related elements that influence the learner from without, namely, curriculum goals, classroom policies and procedures, classroom materials and activities, and communicative exchanges between students, teachers, and administrators. The *internal language environment* was defined as the way in which learners process language in their minds–that is, their native-and second-language systems and the role played by each in performing the cognitive tasks for which the second language is a vehicle. The larger study investigated the selection and use of languages in the performance of all school tasks–social studies, composition writing, science, and math (Parker, Heitzman, Fjerstad, Babbs, & Cohen 1993).

A major focus of this study was the processing of word problems in math (Cohen, forthcoming; Heitzman 1994). Studies of native English-speaking elementary school pupils, for example, had found that difficulty with word problems was largely because of difficulty comprehending abstract or ambiguous language (Cummins, Kintsch, Reusser, Weimer 1988). Thus, it was expected that having to solve such problems in another language would compound the difficulty. Mestre (1988) noted a number of challenges that students face in attempting to solve math word problems in a second language. First, they have to understand the written text in order to understand the problem. Second, they need proficiency in the technical language of the domain. Third, they need to distinguish when a word is being used mathematically and when not, and finally they need proficiency within the symbolic language of the domain.

The following are the specific research questions that were asked: To what extent do learners use their native language and the foreign language when performing the cognitive operations involved in word problems in math? When might a language switch take place, if at all?

Thirty-two students were selected from third through sixth grade at a Spanish full-immersion school in St. Paul. A team of five investigators collected data from the pupils over a five-month period: (1) verbal report, (2) questionnaire data about the pupils' abilities, attitudes, and preferences with regard to thinking in Spanish and with

regard to using Spanish as a vehicle for communication with peers and with adults, (3) insights from classroom observation regarding language use patterns in the process of doing the particular task, and (4) background information on the selected learners, including achievement test scores available from the school office, the learners' school grades, sociolinguistic information on their exposure to Spanish language out of class, and so forth.

The findings revealed that for the immersion students under study English seemed at times to play a more prominent role in their internal language environment than did Spanish. In responding to word problems in math, the 5th and 6th graders in the study reported favoring English in their cognitive processing and were also observed to be doing so. They read the problem in Spanish but would shift to English immediately or as soon as they had some conceptual difficulty. Let us look at data from four pupils. The first two examples are from pupils with medium Spanish language proficiency and medium academic skills, a sixth grader, Ana, and a fifth grader, Peter. The last two examples are from two sixth grade pupils who were high in language proficiency and in academic skills, Karen and Donna.

Ana used an English translation if the word problem was hard:

Researcher: What language do you do math problems in?

Ana: Usually, probably in Spanish. But if it's like a hard word problem, then I have to translate it... Well, I know the words in Spanish. It's just that you want to...you sorta like want to go back to the language you know, like, more of...

She read a math problem in Spanish and solved it in Spanish. In another case, she first read the word problem in Spanish and then translated it into English.

R: Why the translation?

A: Because sometimes English is easier than Spanish.

R: Are there words in the problem you do not understood?

(She indicated **ahorras** [you save] – a crucial word for understanding and solving the problem.)

A: . . . so you gotta have a dictionary with you when you're doing math sometimes. (But she didn't use it.) Well, I just took out the little clues, and said like, "How much money would..." I was just sort of guessing what it meant. . . if you bought something. . . it's like, you add something together and then you come up with the answer and then you minus what you save, and then you come up with the answer.

She then started giving an example of thinking a problem through in Spanish if it was not too hard, but then she switched to English:

> **A**: It's minus. So it's like take away this from this. . .

It appeared not to be a problem of knowing the numbers but of cognitive difficulty–the numbers of operations involved:

> **A**: It's hard for me to remember what number is up here [refers to top integer and fraction in subtraction] and what number is down here [bottom integer and fraction], in Spanish, so I have to translate to English; and then since you can't take away 8 through 9, then I get even more confused...It gets really nuts.

Peter reported using English to understand instructions better. He was just finishing a math test when the researcher arrived. On problems #28 and #29, he seemed to think in English, while on #30 he read the problem aloud, thought in Spanish and later switched to English:

> **Researcher**: When you read these instructions do you understand right away what it says in Spanish or when you read them do you think words in English?
>
> **Peter**: I try and get them into English, so I can understand them a little bit better.
> 30. **Teri usó la computadora 3 veces mas minutos que Sue. ¿Cuánto tiempo trabajó Teri con la computadora?** [Teri used the computer three times more minutes than Sue. How long did Teri work with the computer?]
> OK. Now I think this one might be plus. [He reads the problem aloud in Spanish, then continues.] Sue está aquí, cincuenta y cuatro, uno, dos, tres. . . cincuenta. . . OK.
> ¿Cuánto tiempo. . . ? [Sue is here, 54, 1, 2, 3. . . 50. . . OK. How long?] How many minutes? Three times as many minutes than Sue. . . whoa. OK. Fifty-four times three.

He then set up the problem like this:

$$\begin{array}{r} 54 \\ \underline{\times\ 3} \\ 162 \end{array}$$

> **R**: What were you thinking before you went "OK"?
>
> **P**: I was thinking that Sue, right there, fifty-four; it says three times more. . . than Sue. So, three times four, twelve. Three times five, fifteen six. A hundred and

sixty-two.

In this problem, Peter began thinking about how to do the problem in Spanish. He ran into a problem, and then began to think in English.

Karen reported using English according to the difficulty of the vocabulary, the time of day, and peer group language use at the moment. She was an example of a learner who switched back and forth between Spanish and English freely, but still preferred to use English:

Researcher: Do you do math in Spanish or English?

Karen: The teacher talks to us all the time in Spanish and we have to answer her in Spanish, but usually when I'm just doing it, I'll just speak in English. . . usually.

. . . . It depends upon the time of day, and what the people around me are thinking, because I have them [words] all memorized in both languages. If, like, the environment around me is speaking Spanish, then it'll just happen in Spanish. . .

K: [Going over a math worksheet] I am doing it in English because the math is kind of hard. . . . Also, I've been speaking English most of the day so it just goes along with that. But when I read the directions, it just came in Spanish . . . . Sometimes I know words about math in Spanish that I don't know in English. . . it feels kind of weird to know a word in Spanish but not in English.

Karen discovered these gaps in her technical English vocabulary when trying to explain something to her parents at home. Again, on a worksheet converting from decimals to fractions, she appeared to be performing the cognitive operations in English. At one point she explained a math problem to a peer in Spanish, but mostly they interacted with each other in English, even regarding task-related activities.

R: What language do you do this word problem in?

K: . . . since it's a word problem in Spanish, I would translate it. And maybe do the numbers in Spanish. . . . [With reference to some math problems from the day before that she thought were kind of hard] Well, this one I do. . . actually I usually do these hard ones in English, because they're really difficult. [With respect to an easy problem] This one I did in Spanish, because it was really simple, and there was no vocabulary at all, hardly.

R: [In regard to a geometry worksheet] What language do you do this in?

K: Ah, that's hard. I usually go to English. It's not that the vocabulary's hard to

understand–but the whole project. . . it's kind of easier to think in English because it comes easier–say, GD [referring to a line segment].

Donna used English because it was the community language. She read the word problem in Spanish and then reported thinking through the problem in English, as did other pupils. What she added was a sociolinguistic justification for reverting to English–the fact that English is the language of wider communication in the community at large:

Researcher: Do you know the words for subtract and divide in Spanish?

Donna: . . . it's like a whole 'nother language, the math is. I usually use English vocabulary words. Sometimes I'll use Spanish ones... I mean, sure I've been in a Spanish school, and all, but, you just, the environment I live in, it's not like we speak Spanish there. So, I'm adapted to English more, than in Spanish, so it's easier just to switch to English.

Discussion

The findings from the St. Paul full immersion program could be used to help explain why it is that gaps have been noted in the spoken and written output of immersion pupils. Namely, Spanish is not given adequate prominence in the internal language environments of the learners in order to fill the language gaps noted above. So it is possible, as pointed out above, that during much of the meaning-integration process, the immersion learners are in fact focusing primarily on transformed L1 representations rather than on the original FL forms. The challenge here is to refine the methods for describing the language of thought of bilinguals–to delve into the inner processing to determine the differential uses of the languages in which bilinguals think. Once we have assembled an ample data base it should be easier to make more definitive statements about the reading process in immersion programs. It should also be easier to determine what types of intervention might be advisable to improve the process.

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